EEE-INST-002/003 Revision

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NASA Goddard Space Flight Center

Code 562: Parts, Packaging, and Assembly Technologies Branch

Code 562

To be presented by Christopher M. Green at the NASA Electronic Parts and Packaging Program (NEPP) Electronics Technology Workshop (ETW), NASA Goddard Space Flight Center in Greenbelt, MD, June 23-26, 2015.

Acronyms

Acronym	Definition
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic, and Electromechanical
GSFC	Goddard Space Flight Center
INST	Instruction
LAT	Lot Acceptance Testing
NASA	National Aeronautics and Space Administration
NEPP	NASA Electronic Parts and Packaging
NPR	NASA Procedural Requirements
PCB	Parts Control Board
PCB	Parts Control Board
Qual	Qualification

EEE-INST-002

- GSFC owned document, widely used throughout NASA and industry
  - –003 will also be GSFC owned document
  - –NOT NECESSARILY used/accepted by all NASA centers
- Instructions for EEE Parts Selection, Screening, Qualification, and Derating
- Authored in May 2003
- Addendum 1 added in 2008
- 18 sections
- Corrections and revisions needed

Goals for the Revision

- Update to latest screening practices
- Standardize format across sections
- Include new MIL standards
- New part technologies/sections
- Revision control for individual sections
- Online format to maintain updates
- Better differentiation between Level 1, 2, 3
- Correct errors/inconsistencies

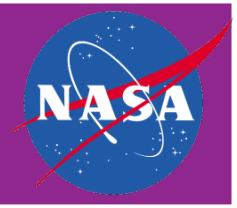
Philosophical Changes

- "Lot Acceptance Testing" replaces "Qualification"
- LAT/Qual by "Heritage" or "Similarity"
  - Requires relevant test data and application information
- DPA requirement specified in Table 1
- GSFC S-311-M-70 for prohibited materials assessment
- Counterfeit Parts Avoidance Plan required
- Use of authorized supply chain required
  - Prior review/approval required for unauthorized sources

Potential New Sections

- Capacitors, Base Metal Electrode
- Fiber Optics and and Passive Components
- Microcircuits, ASICs and Programmable Devices
- Optoelectronic Devices
- Printed Circuit Boards
- RF devices
  - Guidance for GaAs and other devices
- Semiconductor Devices, Plastic Encapsulated (PES)
- Temperature Sensors
  - Thermistors and Platinum Resistance Sensors

Section Layout



- Specific introduction for each section
- Table 1: Use-as-is, Screen, LAT, DPA
- Table 2A, 2B, …: Screening Tests
- Table 3A, 3B, …: Lot Acceptance Tests
- Table 4A, 4B, …: Derating Requirements

Version Control

- EEE-INST-003 implemented for new projects
- EEE-INST-002 to remain published for existing projects
- Both will be available on NEPP
- Individual Section version control
  - Example: EEE-INST-003, Section M1, Rev B
  - Website will maintain version history:
    - Enter a date, print out list of current versions on that date
    - List can be included in project plans, as baseline requirements
    - Older versions will be available/searchable
  - Intent to provide accurate guidance, not add requirements

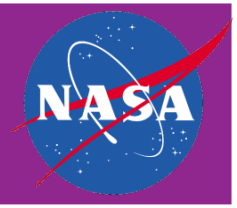
Current Status

- Most existing 002 sections getting reformatting, corrections, and requirement changes
- Internal review within 562/GSFC before larger audience
- Few sections are ready for review
- Many more sections in writing, not ready for review
- Release date: TBD

Review Schedule

- Sections to be reviewed by GSFC Code 562 Parts Engineers and GSFC Commodity Experts
- Widespread external review outside of GSFC is NOT planned prior to release
  - Funding for external review is not available
  - Schedule for external review is not available
  - Individuals may be contacted where expertise is needed
- Sections will be easier to revise/amend

Teaser/test site



UNOFFICIAL EEE-INST-003 for Review

Part Category	Document Section	FSC	Parts Specialists
Section 1: General Instructions for All Part Categories			
Section C1: Capacitors			
Section C2: Capacitors, Base Metal Electrode			
Section C3: Connectors and Contacts			
Section C4: Crystals			
Section C5: Crystal Oscillators			
Section F1: Fiber Optics and Passive Components (Fiber, Cables, Connectors, and Assemblies)			
Section F2: Filters			
Section F3: Fuses			
Fuses	F3	5920	Lou Fetter
Click Here to View Section F3			

Introduction - Fuses

INTRODUCTION

A fuse is a metal strip or thin wire mounted in a non-conducting and non-combustible housing. The fusable element, the metal strip or thin wire, has a small cross-section compared with the rest of the circuit. The resistance of this element is designed so that it does not produce much heat in normal use but produces enough heat to quickly melt the fusable element when the current limit is exceeded. The fuse is placed in series with the circuitry it is intended to protect.

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For both solid and hollow body fuses, the current de-rating factors are based on data from fuses mounted on printed circuit boards and conformally coated. Other types of mountings require Parts Control Board approval. It should be noted that the lifetime of the fuses is controlled by two factors: cold resistance of the fuse, and the heat sinking provided by the installer. The thermal resistance of the fuse to the thermal ground is very important, as is the case with power transistors and power diodes mounted on circuit boards. Electrical transients produce thermal cycling and mechanical fatigue that could affect the life of the fuse. For each application, the capability of the fuse to withstand the expected pulse conditions should be established by considering the pulse cycle withstanding capability for nominal I^2t (energy let through the fuse) specified by the manufacturer.

Table 1 - Requirements

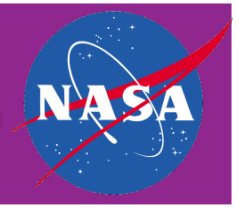

Table 1. FUSE REQUIREMENTS 1/

Quality Level	Fuse Style and Type	Specification	Use as Is	Screening	LAT	DPA
Level 1	FM04 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/4		X 2/		X
	FM08 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/8		X 2/		X
	FM12 Fuse, Instrument Type, Solid	MIL-PRF-23419/12	X			
	Hollow Body, Cartridge	VICD, SCD & Commercial		X 2/	X 3/	X
	Solid Body, Leaded	VICD, SCD & Commercial		X 4/	X 5/	X
	Solid Body, Surface Mount	VICD, SCD & Commercial		X 6/	X 7/	X
Level 2	FM04 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/4		X 2/		X
	FM08 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/8		X 2/		X
	FM12 Fuse, Instrument Type, Solid	MIL-PRF-23419/12	X			
	Hollow Body, Cartridge	VICD, SCD & Commercial		X 2/	X 3/	X
	Solid Body, Leaded	VICD, SCD & Commercial		X 4/	X 5/	X
	Solid Body, Surface Mount	VICD, SCD & Commercial		X 6/	X 7/	X
Level 3	FM04 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/4		X 2/		
	FM08 Fuse, Cartridge, Instrument Type, Hollow Body	MIL-PRF-23419/8		X 2/		
	FM12 Fuse, Instrument Type, Solid	MIL-PRF-23419/12	X			
	Hollow Body, Cartridge	VICD, SCD & Commercial		X 2/	X 3/	X
	Solid Body, Leaded	VICD, SCD & Commercial		X 4/	X 5/	X
	Solid Body, Surface Mount	VICD, SCD & Commercial		X 6/	X 7/	X

Table 2 – Screening

Table 2C. SOLID BODY, SURFACE-MOUNT FUSE SCREENING

Inspection/Test	Test Methods, Conditions, and Requirements	Quality Level		
		1	2	3
1. Visual and Mechanical Inspections	Verify materials, interface, marking, and workmanship. Verify conformance to mechanical dimensions on minimum of three fuses.	X	X	X
2. DC Resistance (DC-Initial)	MIL-STD-202, Method 303 Source current ≤ 10% of nominal current rating at room temperature Resistance to specification	X	X	X
3. Thermal Shock	MIL-STD-202, Method 107, Test Condition B Post-test parts shall show no evidence of mechanical damage nor any loosening of terminals or other parts.	X	X	X
4. DC Resistance (DC-Final)	MIL-STD-202, Method 303 Source current ≤ 10% of nominal current rating at room temperature Resistance to specification	X	X	X
5. DC Resistance Ratio	Allowable change from DC-Initial to DC-Final	≤10%	≤10%	≤10%
6. Percent Defective Allowable (PDA)	Verified failures from Steps 3-5 divided by the number of fuses submitted to Step 3 .	≤5%	≤10%	≤10%
7. Overload Characterization	MIL-PRF-23419, Section 4.7.6.1, at 25°C 20 fuses minimum from the extremes of the truncated lot based on voltage drop ratio Subjected to 250%, 400%, and 600% overload interrupt testing	X	X	X
8. Radiographic Inspection	MIL-STD-202, Method 209, 2 views (0° and 90) Inspection per MIL-PRF-23419/12	X	X	

Table 3 -LAT

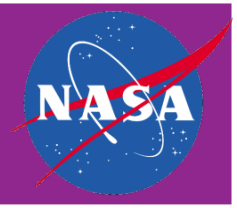

Table 3C. SOLID BODY, SURFACE MOUNT FUSE LOT ACCEPTANCE TEST 1/

Inspection/Test	Test Methods, Conditions, and Requirements	Quantity (Accept Number)		
		Level 1	Level 2	Level 3
Group 1		12(0)	12(0)	
Overload Interrupt	Rated voltage and 25°C case temperature Four fuses per percent rated current 250%, 400%, 600% Temperature soak time: 30 minutes minimum before application to test current Blow time per specification Load time: 1 minute after fuse blow	X	X	
Resistance after Firing	Rated DC voltage across terminals Measurement after 1 minute Resistance ≥ 1 megohm	X	X	
Group 2		4(0)	4(0)	
Solderability	MIL-STD-202, Method 208	X	X	
Group 3		4(0)	4(0)	
Terminal Strength /2	MIL-STD-202, Method 211 Test Condition A 5 pounds pull for fuses rated ≥ 1.0 A; 4 pound pull for fuses rated < 1.0 A Applied axially to each lead wire individually Pre-Terminal Strength Test Measurement: DC Resistance per MIL-STD-202, Method 303, source current ≤ 10% of nominal current rating at room temperature; resistance to specification Post-Terminal Strength Test Measurement: DC Resistance per MIL-STD-202, Method 303, source current ≤ 10% of nominal current rating at room temperature; resistance to specification	X	X	

Table 4 – Derating

Table 4A. HOLLOW BODY FUSE DERATING REQUIREMENTS

Parameter	Limit	Special Conditions
Current Rating @ 25°C: ≥ 2 A	Derating Factor 50% minus 0.2%/°C for an increase in fuse body temperature above 25°C	
Current Rating @ 25°C: ≥ 1A and < 2 A	Derating Factor 45% minus 0.2%/°C for an increase in fuse body temperature above 25°C	
Current Rating @ 25°C: ≥ 0.5A and < 1 A	Derating Factor 40% minus 0.2%/°C for an increase in fuse body temperature above 25°C	The flight use of fuses rated ≤0.5 A require application approval by project Parts Control Board.
Current Rating @ 25°C: ≥ 0.375A and < 0.5 A	Derating Factor 35% minus 0.2%/°C for an increase in fuse body temperature above 25°C	
Current Rating @ 25°C: ≥ 0.25A and < 0.375 A	Derating Factor 30% minus 0.2%/°C for an increase in fuse body temperature above 25°C	
Current Rating @ 25°C: < 0.25 A	Derating Factor 25%	
Operating Temperature	110°C	
Voltage Rating	Derating Factor 80% minus 0.2%/°C for an increase in fuse body temperature above 25°C	

Table 4B. SOLID BODY LEADED AND SURFACE MOUNT FUSE DERATING REQUIREMENTS

Parameter	Limit	Special Conditions
Voltage	Maximum rated voltage	
Current	80% of manufacturer's rating	
Operating Temperature	Manufacturer maximum operating temperature or 125°C, whichever is lower	

Questions?

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BACKUP- Scope

1.1 Scope. The EEE-INST-003 document establishes the minimum set of quality assurance requirements for the selection, testing, and derating of all EEE parts for use on NASA GSFC space flight projects. This document serves as the core element to be used in the parts selection and Parts Control Board (PCB) approval process. Three (3) part quality levels, derived from the payload reliability classifications of NASA NPR 8705.4, are defined in paragraph 3.0, herein.

1.1.1 Applicability. GSFC flight projects and GSFC hardware developers shall reference the EEE-INST-003 instructions in their Project Parts Control Plan (PCP). EEE-INST-003 shall be fully implemented when specified in NASA GSFC Statements of Work (SOWs), Mission Assurance Requirements (MARs), or their equivalents. Henceforth, any use of the word “requirement” assumes compliance to this document is mandatory.

1.1.2 Not Covered. This document does not explicitly address material or mechanical evaluations, radiation testing and requirements, or reliability, but may guide the PCB’s assessment during the EEE part approval process. See Section 7.0 for references to the appropriate organizations to consult in technical areas other than EEE parts.

BACKUP - LAT

Lot Acceptance Testing (LAT). Lot acceptance testing consists of mechanical, electrical, and environmental inspections and is intended to verify that the materials, design, performance, and demonstrated reliability of a EEE part lot is consistent with its specifications, intended application, and mission life requirement. This testing is performed on a prescribed sample quantity of parts from the lot which has been procured for flight.

5.4 Lot Acceptance Tests (LAT). The term Lot Acceptance Testing in this document is used to encompass more generally what the minimum acceptance requirement is for any proposed part at a given mission assurance level. For most commodity types, the required testing closely mimics the Quality Conformance Inspection or verification inspection requirements of their fully qualified military or NASA counterparts. Table 3 in each part category lists the required tests for lot acceptance and shall be performed on a sample of parts from the proposed flight lot. A required test condition is designated with an “X”. The sample size and failure accept criteria, is listed at the beginning of each group or subgroup of tests. Samples submitted to LAT testing shall have successfully completed the screening requirements of the associated Table 2. The tests shall be performed in the order shown within each subgroup. Samples used for lot acceptance testing are considered to be destructively tested and shall not be supplied as flight devices.